

Cobra Invitational, Birmingham Covington School

Wind Power Test

Division B

January 20, 2017

Names: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Team Name and #:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Score

**Directions: provide the *best* answer to each of the questions below. Show all work and use relevant units where applicable. All questions are worth 1 point each unless otherwise indicated. There is a total of 50 possible points on this test.**

1. Which of the following does not function as a primary energy source?
   1. wind
   2. coal
   3. solar
   4. biofuel
   5. electricity
2. Explain briefly what distinguishes a primary energy source from a secondary energy source:

*(2 points)*

1. Which of these energy sources produces the lowest level of CO2 emissions during power generation?
   1. biofuel
   2. coal
   3. propane
   4. natural gas
   5. photovoltaic panels
2. Which of the following is **not** a concern some have regarding wind energy?
   1. It threatens birds whose migratory pathways take them through areas where wind farms are located.
   2. It is a nonrenewable energy source.
   3. It creates dangerous levels of electricity in storms and other times of high winds.
   4. It has a negative impact on the visual appeal of a landscape.
   5. Wind cannot be predicted, unlike solar and geothermal energy.

**Read the following statements regarding the process of transmitting electricity from a power plant, and then answer the questions that follow.**

1. *Electricity is sent on a network of distribution lines.*
2. *Electricity travels to a step-down transformer at a substation.*
3. *Electricity travels by wire to a step-up transformer.*
4. *Electricity is carried to homes and businesses.*
5. *Electricity is generated in a power plant.*
6. What is the correct sequence of steps in this process? Write the corresponding numbers for the steps in proper order:

*(3 points)*

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\_\_\_\_\_\_\_\_/8 points

1. Which of the following choices best describes what a transformer does?
   1. It increases the voltage of the electricity passing through it to reduce losses over power transmission lines.
   2. It reduces the voltage of the electricity passing through it to reduce losses over power transmission lines.
   3. It transforms the current of the electricity into voltage so that it may be safely transmitted from place to place.
   4. It reduces the voltage of the electricity passing through it so that household appliances can use it.
   5. Both a and d are correct
   6. Both b and c are correct.

**Read the following statements carefully. Circle whether each statement is either TRUE or FALSE.**

|  |  |  |
| --- | --- | --- |
| 7. | DC, or direct current, describes the flow of electric charge that changes direction periodically. | TRUE FALSE |
| 8. | Electric power supplied to houses and businesses is almost always in the form of AC, or alternating current. | TRUE FALSE |
| 9. | Batteries and photovoltaic cells supply DC. | TRUE FALSE |
| 10. | Thanks to Thomas Edison, the United States has always used AC to supply electricity to homes and other consumers. | TRUE FALSE |
| 11. | Thanks to George Westinghouse, AC was introduced as a way to supply homes with electricity even if they were many miles from a power plant. | TRUE FALSE |
| 12. | An advantage of AC over DC is that it can be transported over great distances with less loss of energy. | TRUE FALSE |

**For Questions 13-16, read the following four statements about the design advantages of either Horizontal Axis Wind Turbines (HAWT) or Vertical Axis Wind Turbines (VAWT). In the space provided, put a checkmark indicating which wind turbine type demonstrates this advantage.**

HAWT VAWT

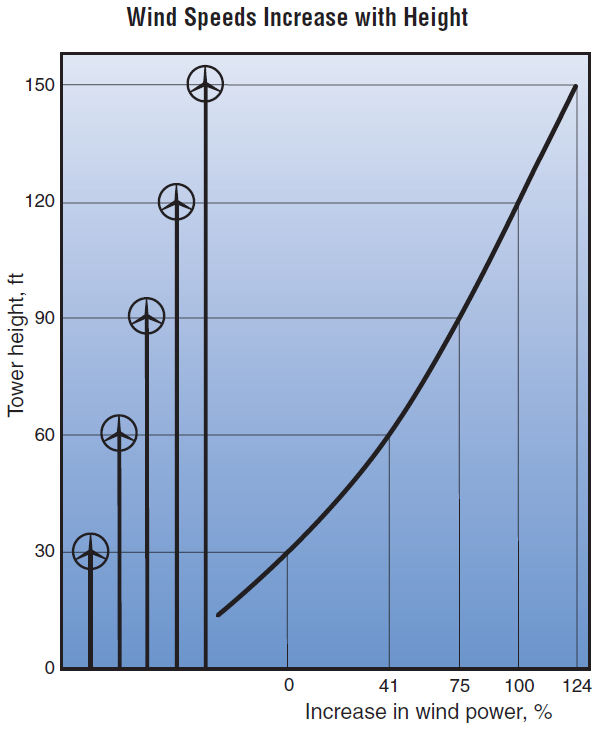
1. Increased access to higher wind energy. ☐ ☐
2. Can be installed in locations where taller structures are ☐ ☐

undesirable or not allowed.

1. Less strain on the axle reduces maintenance needed. ☐ ☐
2. Increased efficiency. ☐ ☐

\_\_\_\_\_\_\_\_/11 points

**Use the graph below to answer Questions 17 and 18.**



1. Based on the graph above, which of the following statements may be concluded?
   1. A tower that is 60 feet tall generates the least power.
   2. Above a certain height, increasing the tower height does not affect the wind power available.
   3. A tower that is 150 feet tall has as much wind power available to it as one that is 90 feet tall.
   4. Wind power increases as tower height increases.
2. Based on your understanding of wind energy, the relationship depicted on the graph above is a result of the following scientific phenomenon:
   1. Vertical axis wind turbines are more efficient.
   2. Wind travels faster, and thus transmits more power, at higher distances above ground.
   3. The greater the area swept by the rotor blades, the higher the power generated by a wind turbine.
   4. Air density increases at greater heights, thus transmitting more power.
3. For power generation, many commercial wind turbines have 3 blades, while some some have two. Explain one advantage of a 2 blade wind turbine, and one advantage of a 3 blade wind turbine. *(4 points)*

\_\_\_\_\_\_\_\_/6 points

1. How much power is available to a 3 blade wind turbine with 6 m blades, if the wind velocity is 7 m/s, and the air density is 1.1 kg/m3? Show all work below, and include relevant equations and units. *(3 points)*
2. Now that you have calculated how much power *is available to* this particular wind turbine at this wind velocity, use your result from the previous question to determine the theoretical maximum power that it can *generate.* Show all work below, and include relevant equations and units. *(3 points)*
3. If this wind turbine produces 100 V and 20 amps at this wind speed, calculate:
   * The power it is generating *(2 points)*
   * Its coefficient of power (Cp) *(2 points)*
4. Why is power storage important when considering “green” (low emissions/renewable) energy sources?

*(3 points)*

1. Provide one example of power storage for each energy type listed below:

*(3 points)*

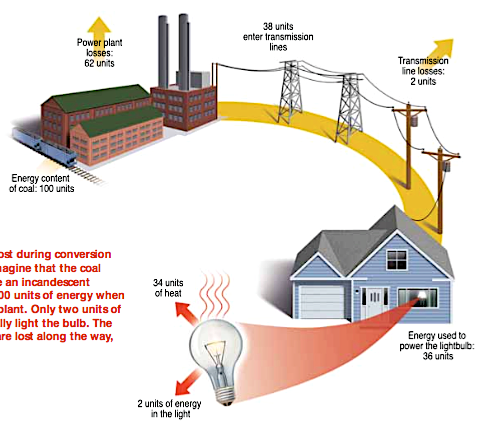
Mechanical:

Chemical:

Thermal:

\_\_\_\_\_\_\_\_/16 points

**Use the diagram below to answer Questions 25-28**



1. Calculate the efficiency of the coal power plant. Include any relevant equations and/or units.

*(2 points)*

1. What percentage of the energy is lost by transmitting it from the power plant to the house?

*(2 points)*

1. Aside from the power plant loss, what is the next largest source of energy loss in the lighting of the incandescent light bulb? Why is this?

*(2 points)*

1. Explain one alternate strategy to improve the overall efficiency in the process of lighting one’s home.

*(2 points)*